Microsoft

The role of embodied carbon in cloud emissions:

Assessing the scale and sources of Microsoft 365 emissions, and what organizations can do to help reduce them

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Introduction

Climate change is an urgent challenge that calls on all of us to think critically about the impact of our actions on the planet. Digital behaviors are no exception to this rule. Since releasing the preview of the Emissions Impact Dashboard for Microsoft 365[1,2] in February, customers have asked what they can do to reduce the environmental impact of their cloud usage, including changes to how people use tools like SharePoint and Microsoft Teams. On its face this feels like a simple question, but the answer is surprisingly complex.

To address it fully, we first need to consider two key points:

1. The role of embodied carbon in datacenter emissions in general,[3] and

2. The scale and proportion of Microsoft 365 datacenter emissions attributable to embodied carbon.

Understanding these two points will help us to identify the most impactful actions that Microsoft can take for reducing the cloud emissions associated with Microsoft 365 use and to recommend concrete actions that customers can take to track and potentially reduce their carbon impact.

[1] Unless otherwise stated, the greenhouse gas emissions and carbon intensity figures in this document are calculated based on the methodology that powers the Emissions Impact Dashboard (EID) for Microsoft 365. This calculation methodology may evolve over time, leading to changes to the figures reported here. The calculations are limited to Microsoft's datacenter emissions associated with commercial customer usage of Exchange Online, SharePoint, OneDrive, Microsoft Teams, Word, Excel, PowerPoint, and Outlook. The calculations do not include usage associated with national cloud deployments such as Microsoft US Government clouds and Office 365 operated by 21Vianet.

[2] The underlying methodologies and emissions findings generated from the EID for Microsoft 365 will differ from those reflected in Microsoft's corporate disclosure. Future updates to the methodologies supporting Microsoft's corporate disclosure will be highlighted accordingly and published annually.

[3] As per the methodology powering the EID for Microsoft 365, embodied carbon includes the greenhouse emissions associated with building, shipping, and recycling datacenter equipment such as servers.

The role of embodied carbon in datacenter emissions

The [Greenhouse Gas Protocol](#) defines three scopes of emissions that organizations use to structure their emissions reporting and identify opportunities for reductions. In the context of Microsoft 365 datacenter emissions, these scopes break down as follows:

Scope 1 | Emissions that **directly result from business activities**, such as stationary combustion of fuels for backup power generation in our datacenters.

Scope 2 | Emissions that **indirectly result from producing the energy consumed in datacenters**, such as exhaust from an electric power plant. The Scope 2 methodology used for the Emissions Impact Dashboard for Microsoft 365 is market-based, meaning that it takes into account Microsoft's renewable energy power purchases.[4] Carbon offsets are not accounted for here.

Scope 3 | Emissions that **indirectly result from the supply chain and all other business activities**, such as the embodied carbon associated with manufacturing, shipping, and recycling the servers used in our datacenters. Scope 3 figures as reported in the Emissions Impact Dashboard for Microsoft 365 can be thought of as a sunk cost; they represent emissions associated with servers and other IT assets that have already been built and installed in our datacenters. Those emissions are amortized over each month of the asset's estimated lifespan (the EID uses a default value of 6 years) before then being allocated to Azure and Microsoft 365 customers and reported in the EID.

For Microsoft 365 datacenter emissions, as in many business contexts, the Scope 3 category dwarfs Scope 1 and Scope 2 combined. The share of Microsoft 365 datacenter emissions attributable to day-to-day operations – Scopes 1 and 2 – averaged just 4% over the course of fiscal year 2022.[5] The far greater share of emissions (96%) was attributable to the supply chain, as reflected in the embodied carbon necessary to build, ship, and recycle datacenter equipment.

96% of Microsoft 365 datacenter emissions were Scope 3

3.5% were Scope 2
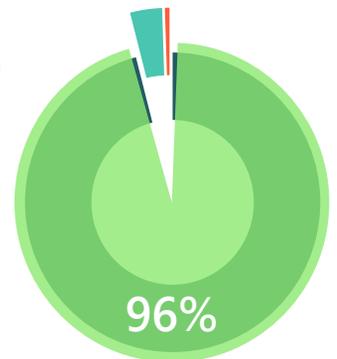
0.5% were Scope 1

96%

Fig. 1 Monthly avg. from July 2021 to June 2022

[4] Microsoft procures both Power Purchase Agreements (PPAs) and Renewable Energy Credits (RECs), and the impact from both is captured in Scope 2 market-based emissions.

[5] This ratio represents a global average across customers and geographies, and the distribution of emissions by scope that organizations see in the EID for Microsoft 365 may differ from the figures shown here.

The high proportion of emissions attributable to Scope 3 is consistent across Microsoft as a whole: our 2021 Environmental Sustainability Report estimated that Scope 3 accounted for about 97% of the company's total emissions for the twelve months ending June 2021.[6] Microsoft is fully committed to becoming carbon negative by 2030, and reducing Scope 3 emissions is a top priority. To help comprehend the size and complexity of Scope 3, in January of this year we published a white paper explaining the EID Scope 3 calculation methodology, providing additional transparency into how we arrive at our figures for that category.

Accurate carbon accounting and effective planning for future carbon reductions require a thorough consideration of Scope 3 emissions and their sources – and any attempt to reduce Microsoft 365 datacenter emissions must also account for the dominance of the Scope 3 category.

Estimating the carbon footprint of Microsoft 365 services

To put the sheer size of Scope 3 in perspective, it is helpful to quantify the datacenter emissions impact of an average Microsoft 365 user and break the impact down by scope. For the month of July 2022, we estimate that the volume of datacenter-driven emissions from providing Microsoft 365 services amounted to approximately 210 grams of carbon dioxide equivalent (CO_2e) per active user,[7] considering all three scopes of emissions enumerated above. For scale, 210 grams is roughly equivalent to driving a little over half a mile (0.8 kilometers) in an average gasoline-powered passenger vehicle or fully charging a smartphone 26 times.[8]

This figure represents a global average across Microsoft 365 commercial users and includes emissions from the electricity and hardware our datacenters use to provide Microsoft 365 services like email delivery through Exchange Online, file storage in SharePoint, and screensharing in Microsoft Teams meetings. Customers can determine the carbon intensity of their organization's own Microsoft 365 use by visiting the 'Carbon Intensity' tab of the Emissions Impact Dashboard for Microsoft 365.

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[6] The underlying methodologies and emissions findings generated from the EID for Microsoft 365 and reported elsewhere in this white paper will differ from those reflected in Microsoft's corporate disclosure.

[7] This is calculated as the total grams of Microsoft 365 datacenter CO_2e emissions across all three scopes divided by total unique active Microsoft 365 commercial users (across Exchange Online, SharePoint, OneDrive, Microsoft Teams, Word, Excel, and PowerPoint) for the month of July 2022. This estimate represents a global average across customers and geographies, and the value that organizations see in the 'Carbon Intensity' tab in the EID for Microsoft 365 may differ from this number.

[8] United States EPA Greenhouse Gas Equivalencies Calculator, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator, September 2022. This equivalency calculation may change over time and is intended for demonstration purposes only.

When limited to Scope 1 and Scope 2 emissions only, however, the average carbon intensity per Microsoft 365 user in July 2022 drops from approximately 210 grams to less than 10 grams: roughly equivalent to driving about 130 feet (40 meters) in an average gas-powered passenger vehicle or fully charging a smartphone just *once*.[9]

Fig. 2 The average Scope 1 and Scope 2 emissions per Microsoft 365 user for the month of July 2022 is estimated to have been less than 10g (roughly equivalent to driving 130 feet in a gas-powered car or fully charging a cell phone once), versus approximately 210g for all three scopes combined.

Compared to emissions from other day-to-day activities like transportation or home electricity use,[10] the per-user carbon intensity of Microsoft 365 services (as of July 2022) is already relatively low. Still, Microsoft is committed to reducing that figure – and our efforts in this space are already bearing fruit.

What Microsoft is doing to reduce the carbon emissions of Microsoft 365 cloud services

Over the course of our 2022 fiscal year, we estimate that the datacenter carbon intensity per gigabyte of data stored in SharePoint and OneDrive per month decreased by more than 30%.[11] And in Microsoft Teams, we estimate that the datacenter carbon intensity of a specific device joining a call for an hour fell by a similar amount, even as we delivered new product value like

[9] Source: United States EPA Greenhouse Gas Equivalencies Calculator, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator, September 2022. This equivalency calculation may change over time and is intended for demonstration purposes only.

[10] United States EPA Greenhouse Gas Equivalencies Calculator, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator, September 2022. This equivalency calculation may change over time and is intended for demonstration purposes only.

[11] This carbon intensity estimate was calculated by dividing the monthly datacenter emissions associated with usage of SharePoint and OneDrive (including compute, bandwidth, and storage) for each month in Microsoft's 2022 fiscal year by the volume of data stored in these tools as of the end of each month.

[AI-based speech enhancements](#).[12,13]

When organizations move productivity workloads to the Microsoft cloud, they benefit from these ongoing improvements. And we are always looking for new ways to further reduce our environmental impact: running services more efficiently on existing datacenter hardware, investing in datacenter energy and resource efficiency, increasing purchases of renewable energy, and more.

Over the past few years, we have invested in running our services more efficiently in ways that we believe have contributed to reductions in the carbon intensity of Microsoft 365 services, including those described above. For example:

Optimizing Azure Compute demand for Teams services: For online Teams meetings, the most critical datacenter resources are compute cores and main memory consumption. In fall 2021 the Teams product group transitioned services to run on optimized cores with approximately 50% lower memory requirements, leading to a reduction in total datacenter resources during a period of time in which the volume of Teams active users increased.

Optimizing peak CPU resource usage for Teams: Today, cloud infrastructure capacity is planned based on our need to satisfy peak customer traffic. A service that has not optimized their peak utilization will increase the number of servers Microsoft has to procure. Net decreases in capacity purchases can directly lead to emissions avoidance. Over the past several years the Teams service improved peak utilization by more than 30%, leading to reductions in the volume of hardware needed to support growth in usage.

Customer experience prioritization for SharePoint and OneDrive: OneDrive and SharePoint implemented standardized headers that require first-party applications to tell the service if a given operation must be prioritized or can be deferred. This has allowed the team to run services at higher utilization while prioritizing customer-impacting operations, contributing to reductions in the number of servers required to support file editing and management workloads.

[12] The technical term for this is a "Teams meeting device hour," which represents a specific device joining a Teams call for an hour. This means that if a given individual dials into a one-hour Teams meeting via their phone for audio and simultaneously via their laptop for screensharing, their participation adds up to two Teams meeting device hours.

[13] These declines do not imply an overall decline in Microsoft 365 datacenter emissions over the course of Microsoft's 2022 fiscal year.

Alongside these efficiencies, Microsoft has also made significant investments in renewable energy – we've committed to having [100 percent of our electricity consumption, 100 percent of the time, matched by zero carbon energy purchases by 2030](#) – and we're also investing to reduce Scope 3 emissions over time. Company-wide, Microsoft is committed to reducing our Scope 3 emissions by more than half by 2030 – and we're engaging on multiple fronts to achieve that goal. Our [2021 Environmental Sustainability Report](#) describes a whole host of such initiatives, including:

- Designing embodied carbon out of our buildings – both our campuses and our datacenters,
- Engaging with our suppliers on emissions reduction roadmaps,
- Providing new tools and training for supplier reporting,
- Building new forms of financing for suppliers,
- Reimagining circularity in our supply chain, and
- Using lifecycle assessments for targeted hardware improvements.

In parallel, we are also committed to empowering our customers and partners to reduce their carbon footprints through our learnings and with the power of data, AI, and digital technology, through tools like the [Microsoft Sustainability Manager](#) and the [Emissions Impact Dashboards for Microsoft 365 and for Azure](#).

Opportunities for Microsoft 365 admins and users to impact Scope 3 emissions

As demonstrated in the first section of this paper, any attempts to influence the datacenter emissions associated with Microsoft 365 services must take into account the dominance of the Scope 3 category (i.e., the embodied carbon associated with the manufacturing, shipping, and recycling servers and other datacenter IT assets). Customer actions can potentially influence this category, but only in an indirect manner and over a relatively long-time horizon. Microsoft plans future datacenter capacity needs based on projections of future usage and data storage, and these plans may change as the result of broad and sustained changes in admin and user behaviors. Any such changes would, in turn, have an effect on future Scope 3 emissions. With that in mind, here are a few ways Microsoft 365 admins and end users could have a potential positive impact on Microsoft's future datacenter emissions:[14]

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[14] Adoption of these behaviors and policies may not lead to immediate noticeable reductions in emissions values reported in the Emissions Impact Dashboard for Microsoft 365.

Admins can:

Configure retention periods for your organization's data. Admins can apply retention policies for Microsoft 365 applications to reduce the volume of data over time. Learn more:

- [Exchange Online retention](#)

- [SharePoint and OneDrive retention](#)

- [Microsoft Teams chat and channel retention](#)

- [Microsoft Teams meeting recording retention](#)

Use the [Emissions Impact Dashboard for Microsoft 365](#) to quantify your organization's allocation of Microsoft 365 datacenter emissions. You can also share the data with other internal stakeholders and estimate emissions already avoided by migrating productivity workloads to the cloud. This dashboard complements the [Emissions Impact Dashboard for Azure](#).

Leverage the [Microsoft 365 usage reports](#) to track trends in overall application usage as well as data storage in Exchange Online, SharePoint, and OneDrive.

Explore aggregated Microsoft 365 usage insights with [Adoption Score](#) – including [this insight](#) on the number of people that use SharePoint or OneDrive to collaborate on documents using links.

Use [Microsoft Sustainability Manager](#) to record, report, and reduce your organization's overall environmental impact. It also makes it possible to place datacenter emissions in the context of your organization's overall IT or corporate carbon footprint.

End users can:

Use the [Sweep feature in Outlook](#). The Sweep feature allows users to quickly delete unwanted email in their Outlook inbox. Note that an email will not be fully purged for a given mailbox if admins have [enabled single item recovery](#) for that mailbox.

Collaborate with OneDrive links. By using links to files stored on SharePoint or OneDrive as opposed to emailing around attachments, users can reduce the volume of data they create when sharing and collaborating on documents. Attachments result in a replica of a given file being stored in the sender's and in each recipients' mailbox, whereas with links, a single centralized version of the file is maintained without unnecessary duplication.

Unsubscribe from distribution lists that aren't read. By doing so, users can avoid having emails unnecessarily sent to and stored in their Exchange Online mailbox.

Clean up distribution lists. Users who send newsletters or other internal communications to large distribution lists can reduce unnecessary data creation by removing contacts that don't engage with the emails. The Microsoft Viva Insights Outlook add-in offers the ability to [track email open rates](#), so users can determine if their distribution list needs to be cleaned.

Conclusion

Addressing the root causes of climate change will take concerted action by all of us, both immediately and well into the future. The clearer we can be about where we can make the most impact, both as individuals and as organizations, the more effectively we can target our efforts. With respect to datacenter emissions, this means building ever-more transparency and clarity around the enormous role of value chain emissions and embodied carbon, and how we can reduce them, in addition to making continued investments in renewable energy and reductions in energy consumption. We hope the insights presented above help to give our customers a foundation for thinking through where they can make the most difference – whether through changes to how employees and admins use and configure Microsoft 365 tools, or by casting a broader view toward reducing embodied carbon throughout the value chain.